

Research Problem Review 79-3

**LEVEL II**

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**DEGREE OF TRAINING AND ARTILLERY  
CONTROL CONSOLE OPERATOR  
(ACCO) PROFICIENCY**

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Army Project Number

16 2Q263743A775

Human Performance in  
Field Assessment

Research Problem Review 79-3

6  
DEGREE OF TRAINING AND ARTILLERY CONTROL CONSOLE  
OPERATOR (ACCO) PROFICIENCY

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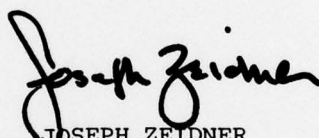
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## FOREWORD

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The Fort Hood Field Unit of the Army Research Institute (ARI) for the Behavioral and Social Sciences conducts research and provides technical advisory service for the Training and Doctrine Command (TRADOC) Combined Arms Test Activity (TCATA). In the summer of 1977, the Commanding General of TRADOC requested that ARI conduct a performance evaluation of TACFIRE Artillery Control Console Operators (ACCOs) to serve as an input to the cost training effectiveness analysis (CTEA) of the TACFIRE system. TACFIRE is a newly developed automated command and control system for the field artillery. ACCOs function at the computer consoles located at the battalion and division artillery Fire Detection Centers and are integral to the overall effectiveness of the TACFIRE system.

The entire project is responsive to special requirements of the office of the Deputy Chief of Staff for Personnel and to Army Project 2Q263743A775.

  
JOSEPH ZEIDNER  
Technical Director

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DEGREE OF TRAINING AND ARTILLERY CONTROL CONSOLE OPERATOR  
(ACCO) PROFICIENCY

BRIEF

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Requirement:

To assess the proficiency of TACFIRE ACCOs as a function of amount of training with the TACFIRE equipment. *was assessed*

Procedure:

Operators' proficiency at the artillery control console (ACC) was assessed at their graduation from formal TACFIRE training and after 2½ months and 5½ months of on-the-job training (OJT). A practical exercise consisting of 10 processing requirements for the ACCO (e.g., inputting targets into the battalion target file, processing a search of the division artillery intelligence file, establishing a fire plan) was developed. Eight of the processing requirements were timed for each operator, and all processing requirements were divided into sub-requirements, which were scored for accuracy. Operators were run individually in the TACFIRE computer shelters.

Findings:

No differences were found among the three groups with respect to processing accuracy. However, enlisted operators were significantly faster after having received OJT than at graduation. No significant differences were obtained between the 2½ and 5½ month OJT groups.

Utilization of Findings:

These findings impact on future TACFIRE ACCO training. Findings have been integrated into TRADOC's cost training effectiveness analysis (CTEA) of the TACFIRE system.

- i -

DEGREE OF TRAINING AND ARTILLERY CONTROL CONSOLE OPERATOR  
(ACCO) PROFICIENCY

CONTENTS

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	Page
INTRODUCTION . . . . .	1
OBJECTIVE . . . . .	1
METHOD . . . . .	1
RESULTS . . . . .	2
CONCLUSIONS . . . . .	5
TECHNICAL SUPPLEMENT . . . . .	7

LIST OF FIGURES

Figure 1. Mean percent of subrequirements missed . . . . .	3
2. Mean response times . . . . .	4

## DEGREE OF TRAINING AND ARTILLERY CONTROL CONSOLE OPERATOR (ACCO) PROFICIENCY

### INTRODUCTION

TACFIRE is a computerized command and control system for the field artillery. At the heart of the TACFIRE system is the artillery control console (ACC). ACCs are located at the division artillery and the battalion fire direction centers (FDCs). Although the fire direction sergeant has primary responsibility for operating the ACC, other FDC personnel (e.g., fire direction officer, TACFIRE equipment specialist) typically take turns at the console during tactical operations. Because the FDC is critical to TACFIRE system performance, an extensive training program was administered to all FDC personnel prior to TACFIRE OT 056. FDC personnel received 10 weeks of formal course training at Fort Sill, Okla., prior to entering a dedicated, on-the-job (OJT) training phase at Fort Hood, Tex. This OJT phase lasted until the onset of operational testing. Approximately half the OT 056 FDC personnel completed their formal training at the beginning of June 1977. The remaining FDC personnel completed their formal training at the beginning of September 1977. Hence, a difference of approximately 3 months total OJT time existed between the two groups.

A question of interest to both test personnel and to individuals performing the cost training effectiveness analysis (CTEA) of the TACFIRE system for TRADOC was whether or not there was a detectable performance difference that was attributable to this 3-month difference in training time.

### OBJECTIVE

The objective of this research was to assess ACCO proficiency as a function of the degree of training with the TACFIRE equipment.

### METHOD

A practical test<sup>1</sup> was developed, and it could be administered to an individual operator in half an hour. The test consisted of 10 requirements (e.g., inputting targets into the battalion target file, processing a search of the division artillery intelligence file,

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<sup>1</sup>The test is controlled, since it will be administered in future testing. Information about the test can be requested by writing Chief, ARI Field Unit, HQ TCATA (PERI-OH), Fort Hood, Tex. 76544.



establishing a fire plan). The first two requirements comprised messages sent to the operator. For these first two requirements, operators were asked questions about the messages and asked to take appropriate action. The remaining eight requirements required specific operator actions and were timed for each operator. All 10 processing requirements were divided into subrequirements which were stringently scored on a go/no-go basis.

The initial test was administered at Fort Hood in mid-November 1977 by the training assistance team from Fort Sill. This test was conducted simultaneously at the four battalion FDCs and at the division artillery FDC. A subsequent iteration of the test was administered at Fort Sill by the TACFIRE instructors on the USAFAS computers in early April 1978. This subsequent iteration was run to establish a performance baseline at graduation from formal TACFIRE training.

The basic rationale underlying the study was to compare the performance of these three classes to determine whether or not there were differences in operator proficiency attributable to training experience. The three points of evaluation were at TACFIRE graduation (the Fort Sill test in April 1978), after 2½ months of postgraduation OJT (the September 1977 class), and after 5½ months of postgraduation OJT (the June 1977 class).

## RESULTS

The results are portrayed in Figures 1 and 2. Summaries of the statistical analyses are presented in the Technical Supplement. These statistical analyses ( $\alpha = .05$ ) revealed that the differences among the three classes with respect to performance accuracy were not statistically significant. However, statistical analyses of the processing time, when restricted to enlisted personnel, did reveal statistically significant differences. Further analyses indicated that whereas the processing times for the June and September classes were significantly faster than the processing times for the graduating class, the processing times of the former two classes did not differ significantly from each other. The small numbers of officers represented in the sample, coupled with their disproportionate distribution among the classes, precluded any meaningful analysis of officer proficiency.

Analyses were also performed on TACFIRE course grades to ascertain whether the classes differed in aptitude or general knowledge. These analyses revealed no significant differences in the school performance of these three classes.



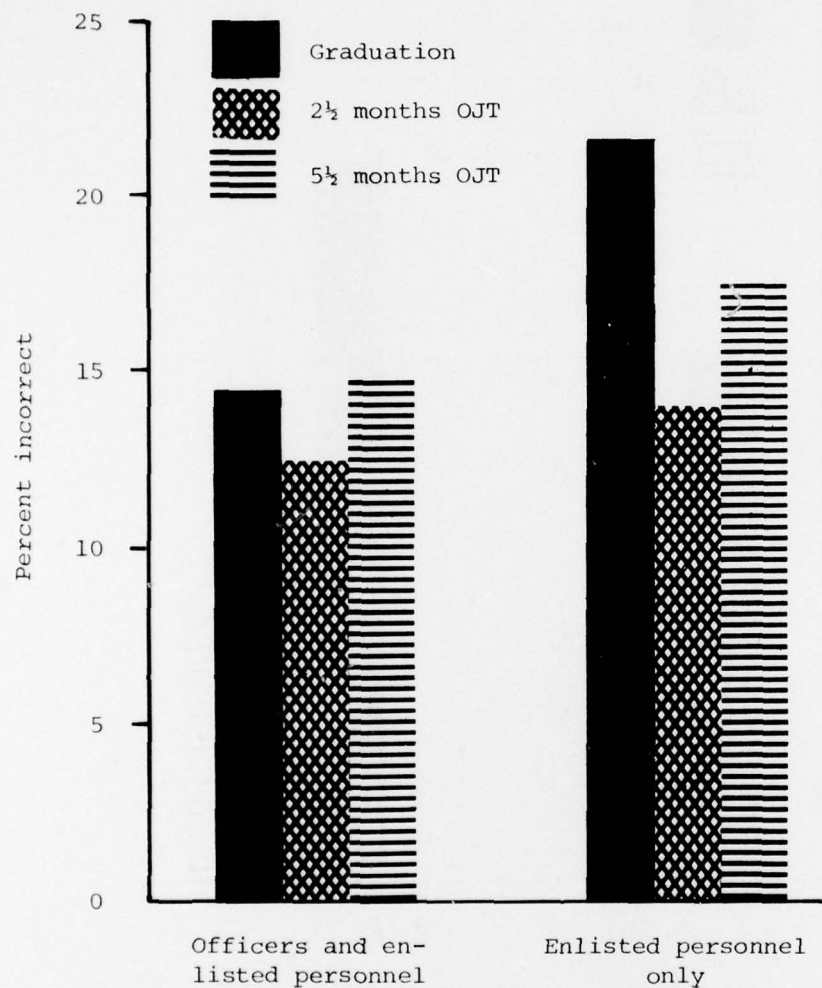


Figure 1. Mean percent of subrequirements missed.

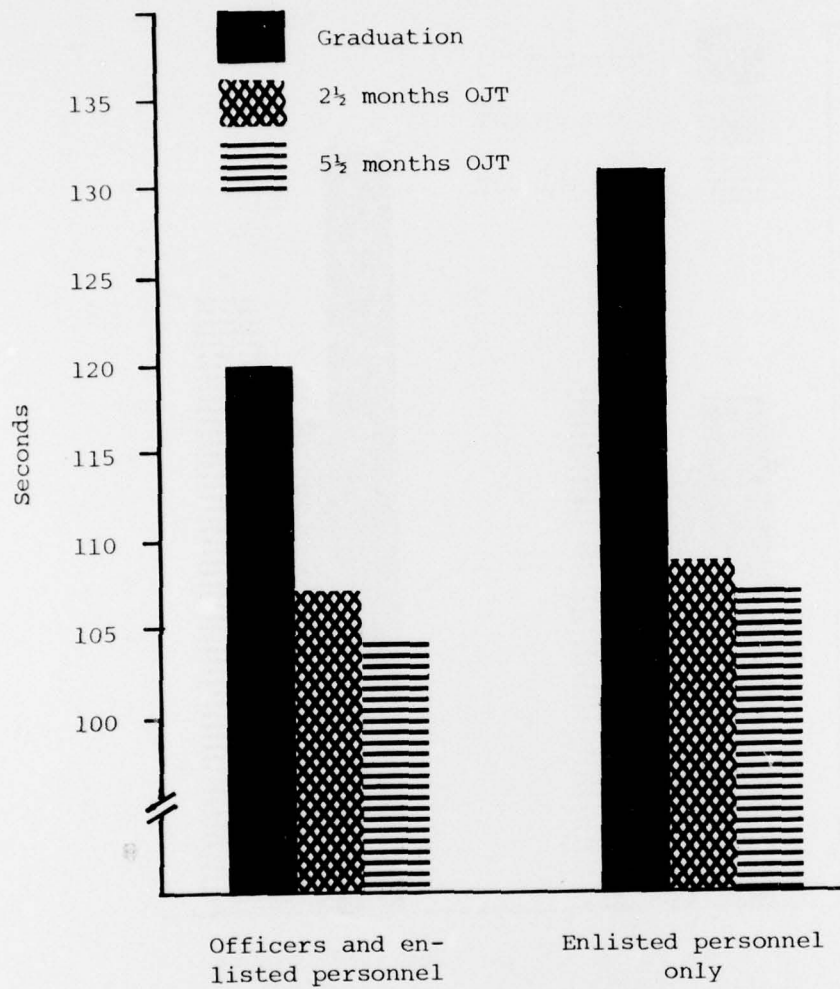


Figure 2. Mean response times.

## CONCLUSIONS

The primary conclusion is that by the time enlisted graduates of the Fort Sill Fire Support Course have completed 2½ months of intensive hands-on training, operator proficiency has essentially leveled off. Another conclusion is that the skills of individual operators improved during the initial phase of OJT. The precise point at which operators' skills level off remains to be determined empirically.

A number of caveats must be extended concerning the above conclusions. Assumptions regarding the reliability and validity of the test are discussed in the Technical Supplement. Note also that the above conclusions are specific to enlisted personnel and are specific to individual operator proficiency. For example, the fact that individual operator proficiency leveled off does not necessarily imply a corresponding leveling off of overall system proficiency. Only specific individual operator tasks were assessed. Neither FDC proficiency as a team nor proficiency in the field was assessed. Certain special properties of team performance (e.g., the quality of supervision) and special problems encountered in the field (e.g., communications) can profoundly affect system performance. Moreover, these factors themselves can be modified by training.

#### TECHNICAL SUPPLEMENT

Preliminary analyses were conducted to assess the comparability of the three classes. Mean class averages were 83%, 85%, and 84% for the April 1978 (Graduation), September 1977 (2½ month OJT), and June 1977 (5½ month OJT) classes, respectively. An unweighted means ANOVA<sup>2</sup> revealed no significant differences among the three classes,  $F(2, 41) < 1.00$ . Because the April 1978 class contained a disproportionately high percentage of officers (42% versus 30% and 27% for the September 1977 and June 1977 classes, respectively), it was deemed prudent also to conduct the analyses employing only the scores of enlisted personnel. Mean class averages, when restricted to enlisted personnel, were 79%, 82%, and 80% for the April 1978 (Graduation), September 1977 (2½ month OJT), and June 1977 (5½ month OJT) classes, respectively. The unweighted means ANOVA of these scores again revealed nonsignificant effects,  $F(2, 26) < 1.00$ . Hence, it was concluded that subsequent analyses could be legitimately related to training conditions.

The means percent incorrect were 14.93, 12.10, and 14.74 at graduation, and after 2½ months and 5½ months of postgraduation OJT, respectively. The unweighted means ANOVA of these scores indicated that the obtained differences were nonsignificant,  $F(2, 41) < 1.00$ . When officers were excluded from the preceding analyses, the means were 21.36%, 13.57%, and 17.00% at graduation, and after 2½ and 5½ months of OJT following graduation, respectively. Again, the unweighted means ANOVA revealed nonsignificant effects,  $F(2, 26) = 1.024$ ,  $p > .25$ . Thus, total training time had no significant effect on operator accuracy.

The mean response times were 120 seconds, 107 seconds, and 104 seconds at graduation, 2½ months, and 5½ months, respectively. The unweighted means ANOVA of these times revealed a nonsignificant effect,  $F(2, 41) = 2.37$ ,  $p > .10$ . However, when officers were excluded from this analysis, the effect became significant,  $F(2, 26) = 3.91$ ,  $p < .05$ . When restricted to enlisted personnel, the mean response times were 131 seconds, 109 seconds, and 107 seconds at graduation, 2½ months, and 5½ months, respectively. A Newman-Keuls test ( $\alpha = .05$ ) of these means indicated that, whereas the classes at 2½ months and 5½ months were significantly faster than the class tested at graduation, the classes at 2½ and 5½ months were not significantly different from each other. Thus, the speed of performance of the enlisted operators did improve during OJT. However, after 2½ months, no further improvement in speed was detected.

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<sup>2</sup>Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1971.



Additional analyses were also done on a natural logarithm transformation of the response times. In one set of analyses, each response time for each requirement was transformed to its natural logarithm, and then the mean of the transformed scores was employed as the dependent variable. The unweighted means ANOVA of these scores revealed a significant effect,  $F(2, 41) = 3.78, p < .05$ . The means of the transformed scores were 4.481, 4.234, and 4.267 at graduation, 2½ months, and 5½ months, respectively. The Newman-Keuls test ( $\alpha = .05$ ) of these means again indicated that whereas the classes at 2½ months and at 5½ months were significantly faster than the class tested at graduation, the classes at 2½ months and at 5½ months were not significantly different from each other. The same pattern of results obtained when officers were excluded from the analysis,  $F(2, 26) = 6.28, p < .01$  ( $\bar{x} = 4.579, 4.223, \text{ and } 4.288$  at graduation, 2½ months, and 5½ months, respectively).

A second set of analyses was done on the natural logarithmic transformation of the mean processing times for each operator. This analysis is not identical with the preceding one, because the mean of a nonlinear transformation is not the same as the nonlinear transformation of the mean. The unweighted means ANOVA of the transformation of the mean scores revealed a nonsignificant effect,  $F(2, 41) = 2.31, p < .05$ . The means of the transformed means were 4.776, 4.652, and 4.625 at graduation, 2½ months, and 5½ months, respectively. However, when officers were excluded from the analysis, the effect became significant,  $F(2, 26) = 4.02, p < .05$ . With the officers excluded, the means became 4.869, 4.669, and 4.658 at graduation, 2½ months, and 5½ months, respectively. The Newman-Keuls test ( $\alpha = .05$ ) indicated that, whereas the first mean was significantly different from the others, the latter two means did not differ significantly from each other. Note that the pattern of results from this set of analyses is identical with that of the untransformed scores.

Given the above analyses, the prudent course is to restrict generalizations about the data to enlisted personnel. Since officers, on the whole, tended to perform at a higher level than enlisted personnel, and since officers were not represented proportionately in each group, generalizations with respect to officers remain highly tenuous. Moreover, only one of the analyses in which officers were included yielded significant effects. However, the results regarding enlisted personnel are quite firm--the speed of operator performance did improve after intensive periods of OJT, and this speed leveled off by the time operators had received 2½ months of intensive OJT.

Of course, generalizing from the results of the above test to "true" operator proficiency requires a high degree of test validity. At this time it is uncertain how representative this test is of true operator proficiency. Unfortunately, the time constraints imposed upon the study and the limited number of TACFIRE-trained personnel precluded a rigorous procedure of test development inclusive of formal

assessments of reliability and validity. Although the test appears to have excellent face validity, it is recommended that validity be properly assessed in the future. Moreover, it is recommended that a pool of similar tests be developed for the assessment of operator proficiency.